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ELECTROLESS COPPER PLATING DEVICE

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Abstract

PROBLEM TO BE SOLVED: To provide an electroless copper plating device capable of prolonging the service life of a plating soln. facilitating the management of the plating soln. by suppressing the Cannizzaro reaction as it is as much as possible.

SOLUTION: This device is provided with a plating treating tank 11 holding a substrate W and applying electroless copper plating on the substrate W and a plating soln. circulating tank 12 stored with a plating soln. 10 at the inside and circulating the plating soln. 10 between it and the plating treating tank 11, and the temp. T1 of the plating soln. 10 in the plating treating tank 11 is made higher than the temp. T2 of the plating soln. 10 in the plating soln. circulating tank 12 (T1>T2).

TOP

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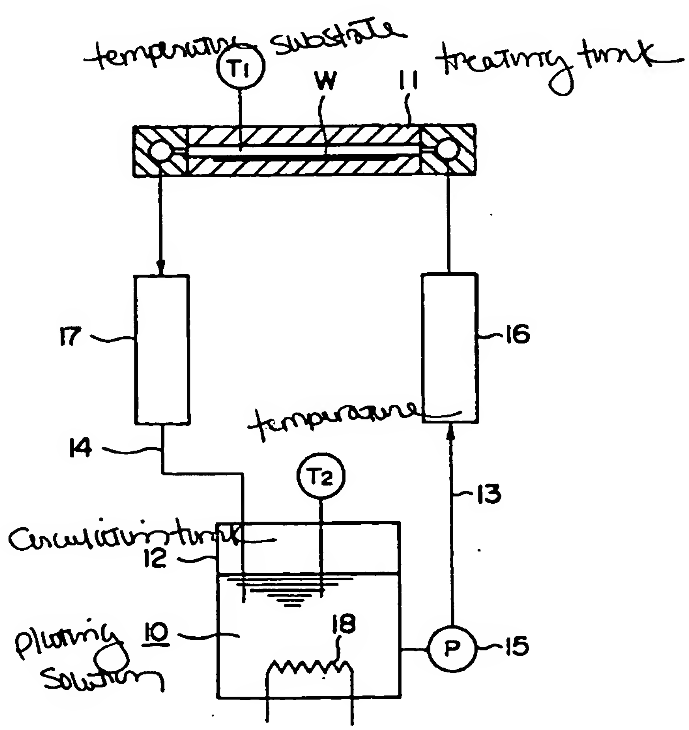
(54)【発明の名称】　無電解銅めっき装置

(57)【要約】
【課題】　カニッツァーロ反応そのものを極力抑制して、めっき液の寿命を延ばすとともに、めっき液の管理を容易とした無電解銅めっき装置を提供する。
【解決手段】　基板Ｗを保持し該基板Ｗに無電解銅めっきを施すめっき処理槽１１と、内部にめっき液１０を貯めめっき処理槽１１との間でめっき液１０を循環させるめっき液循環槽１２とを備え、めっき処理槽１１内のめっき液１０の温度T_1がめっき液循環槽１２内のめっき液１０の温度T_2よりも高く（$T_1 > T_2$）なるようにした。



【特許請求の範囲】

【請求項１】　基板を保持し該基板に無電解銅めっきを施すめっき処理槽と、内部にめっき液を貯め前記めっき処理槽との間でめっき液を循環させるめっき液循環槽とを備え、

前記めっき処理槽内のめっき液の温度が前記めっき液循環槽内のめっき液の温度よりも高くなるようにしたことを特徴とする無電解銅めっき装置。

【請求項２】　前記めっき処理槽内のめっき液の温度と前記めっき液循環槽内のめっき液の温度の温度差が、少なくとも１０℃以上であることを特徴とする請求項１記載の無電解銅めっき装置。

【請求項３】　前記めっき液循環槽から前記めっき処理槽への往路に加熱装置が、復路に冷却装置がそれぞれ設けられていることを特徴とする請求項１または２記載の無電解銅めっき装置。

【請求項４】　対向式熱交換器を備え、この対向式熱交換器の加熱側に前記めっき処理槽に入るめっき液が、冷却側に前記めっき液循環槽に戻るめっき液がそれぞれ流れるようにしたことを特徴とする請求項１または２記載の無電解銅めっき装置。

【請求項５】　前記対向式熱交換器とめっき処理槽とを結ぶ経路内に加熱装置が、前記対向式熱交換器とめっき液循環槽とを結ぶ経路内に冷却装置がそれぞれ設けられていることを特徴とする請求項４記載の無電解銅めっき装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、無電解銅めっき装置に係り、特に半導体基板に形成された配線用の溝に銅を充填する等の用途の無電解銅めっき装置に関する。

【０００２】

【従来の技術】従来、半導体基板上に配線回路を形成するためには、基板面上にスパッタリング等を用いて導体の成膜を行った後、さらにレジスト等のパターンマスクを用いたケミカルドライエッチングにより膜の不要部分を除去していた。

【０００３】配線回路を形成するための金属材料としては、一般にアルミニウム（Ａｌ）又はアルミニウム合金が広く用いられていた。しかしながら、半導体の集積度が高くなるにつれて配線幅が細くなり、電流密度が増加して熱応力や温度上昇を生じ、ストレスマイグレーションやエレクトロマイグレーションによって、ついには断線或いは短絡等のおそれが生じる。この傾向は、アルミ配線が薄膜化するに従いさらに顕著となる傾向にある。

【０００４】そこで、通電による抵抗損失を避けるため、より導電性の高い銅などの材料を配線形成に採用することが要求されている。しかしながら、銅又はその合金はドライエッチングが難しく、基板全面に成膜してからパターンを形成する上記の方法の採用は困難である。そこで、予め所定パターンの配線用の溝を形成しておき、その中に銅又はその合金を充填する工程が考えられる。これによれば、膜をエッチングにより除去する工程は不要で、表面段差を取り除くための研磨工程を行うことで銅配線層を形成できる。また、多層配線回路の上下層を連絡するプラグと呼ばれる部分も同時に形成することができる利点がある。

【０００５】しかしながら、このような配線溝あるいはプラグの形状は、配線幅が微細化するに伴いかなりの高アスペクト比（深さと直径又は幅の比）となり、スパッタリング成膜では均一な金属の充填が困難であった。また、種々の材料の成膜手段として化学的気相成長（ＣＶＤ）法が用いられるが、銅又はその合金では、適当な気体原料を準備することが困難であり、また、有機原料を採用する場合には、これから堆積膜中へ炭素（Ｃ）が混入してマイグレーション性が上がるという問題点があった。そこで、基板をめっき液中に浸漬させて無電解銅めっきを行なう方法が提案されている。係るめっきによる成膜では、高アスペクト比の配線溝を均一に銅で充填することが可能となる。

【０００６】ここに、無電解銅めっきに使用されるめっき液には、ホルマリン（ＨＣＨＯ）やグリオキシル酸（ＣＨＯＣＯＯＨ）などの還元剤が含まれている。また無電解銅めっきでめっき析出速度と皮膜の品質（伸び）を上げる場合のめっき液の適温は、５０～８０℃前後であり、このため、めっき液は、一般に加熱装置を備えた恒温槽（めっき液循環槽）内に一定の温度（６０℃前後）で貯蔵されていて、めっき処理を行うめっき処理槽との間を循環させるように構成されていた。

【０００７】

【発明が解決しようとする課題】無電解銅めっきに使用されるめっき液には還元剤が含まれているため、この還元剤の副反応であるカニッツァーロ反応、すなわちホルマリンやグリオキシル酸にあっては下記の反応が生じる。

$$2HCHO+OH^- \rightarrow CH_3OH+HCOO^-$$

$$2CHOCOOH+2OH^- \rightarrow C_2O_4{}^{2-}+HOCH_2COOH+H_2O$$

【０００８】そして、この反応を完全に抑制することが不可能であるため、この反応によって生成された副生成物がめっき液の純度や溶存酸素量を低下させ、めっき成長速度に影響を与えてしまう。このため、無電解銅めっきは、管理しにくいめっき方法であるのが現状であった。なお、カニッツァーロ反応に起因するめっき液の劣化を防止するため、めっき液にメタノールを添加することが行われているが、この方法は、カニッツァーロ反応そのものを抑制するものではなく、その効果には一定の限界があった。

【０００９】本発明は上記事情に鑑みて為されたもので、カニッツァーロ反応そのものを極力抑制して、めっ

き液の寿命を延ばすとともに、めっき液の管理を容易とした無電解銅めっき装置を提供することを目的とする。

【0010】

【課題を解決するための手段】本発明の無電解銅めっき装置は、基板を保持し該基板に無電解銅めっきを施すめっき処理槽と、内部にめっき液を貯め前記めっき処理槽との間でめっき液を循環させるめっき液循環槽とを備え、前記めっき処理槽内のめっき液の温度が前記めっき液循環槽内のめっき液の温度よりも高くなるようにしたことを特徴とする。

【0011】上記本発明によれば、上記カニッツァーロ反応は、熱活性化過程で促進されていると考えられ、めっき液の温度を低下させることで、この反応を抑制することができる。そこで、めっき処理槽内のめっき液の温度を基板のめっき浴の適温に、めっき液循環槽内のめっき液の温度を基板のめっき浴の適温より低い温度にすることで、通常、殆どの時間めっき液が保持されているめっき液循環槽内でのカニッツァーロ反応そのものを抑制することができる。

【0012】また、前記めっき処理槽内のめっき液の温度と前記めっき液循環槽内のめっき液の温度の温度差が、少なくとも10℃以上であることを特徴とする。これにより、めっき液循環槽内のめっき液の温度を基板のめっき浴の適温から10℃以上低下させることで、カニッツァーロ反応の速度を半分以下に下げることができる。

【0013】また、前記めっき液循環槽から前記めっき処理槽への往路に加熱装置が、復路に冷却装置がそれぞれ設けられていることを特徴とする。これにより、めっき液をめっき処理槽に入る直前に加熱装置で基板のめっき浴の適温まで加熱し、めっき液循環槽に戻る前に冷却装置で冷却することができる。

【0014】更に、対向式熱交換機を備え、この対向式熱交換器の加熱側に前記めっき処理槽に入るめっき液が、冷却側に前記めっき液循環槽に戻るめっき液がそれぞれ流れるようにしたことを特徴とする。これにより、めっき液の持つ熱量をめっき液の加熱及び冷却に有効に利用して、エネルギの消費を最小限に抑えることができる。

【0015】また、前記対向式熱交換器とめっき処理槽とを結ぶ経路内に加熱装置が、対向式熱交換器とめっき液循環槽とを結び経路内に冷却装置がそれぞれ設けられていることを特徴とする。これにより、対向式熱交換器による熱量の不足分を加熱装置及び冷却装置で補うことができる。

【0016】

【発明の実施の形態】以下、本発明の実施の形態の無電解銅めっき装置について図面を参照して説明する。この無電解銅めっき装置は、半導体基板の表面の溝に銅めっきを施して、銅層からなる配線層を形成するのに使用され、この工程を図1を参照して説明する。

【0017】即ち、半導体基板Wには、図1(a)に示すように、半導体素子が形成された半導体基板1上の導電層1aの上にSiO_2からなる絶縁膜2が堆積され、リソグラフィ・エッチング技術によりコンタクトホール3と配線用の溝4が形成され、その上にTiN等からなるバリア層5が形成されている。

【0018】そして、図1(b)に示すように、前記半導体基板Wの表面に銅めっきを施すことで、半導体基板1のコンタクトホール3及び溝4内に銅を充填させるとともに、絶縁膜2上に銅層6を堆積させる。その後、化学的機械的研磨(CMP)により、絶縁膜2上の銅層6を除去して、コンタクトホール3および配線用の溝4に充填させた銅層6の表面と絶縁膜2の表面とをほぼ同一平面に研磨する。これにより、図1(c)に示すように銅層6からなる配線が形成される。

【0019】図2は、本発明の第1の実施の形態の無電解銅めっき装置の概要を示すもので、同図に示すように、このめっき装置には、半導体基板Wを保持し、めっき液10を内部に導入して該半導体基板Wに無電解銅めっきを施すめっき処理槽11と、めっき液10を貯め前記めっき処理槽11との間でめっき液10を循環させるめっき液循環槽12とが備えられている。前記めっき液10には、還元剤として、例えば0.1mol/リットルのホルマリンが含まれている。

【0020】前記めっき液循環槽12とめっき処理槽11とは、循環経路を構成する往路13と復路14で結ばれ、この往路13には循環用ポンプ15と加熱装置16が、復路14には冷却装置17がそれぞれ設けられている。更に、前記めっき液循環槽12の内部には、ここに貯蔵しためっき液10の温度を一定にするための熱交換器18が配置されている。

【0021】これにより、めっき液10は、循環用ポンプ15の駆動に伴って、めっき処理槽11内に順次送られ、基板のめっき浴終了後にめっき液循環槽12内に戻される。この時、めっき処理槽11内のめっき液10の温度T_1が基板のめっき浴の適温である、例えば60℃前後となるように加熱装置16で加熱される。一方、めっき液循環槽12内に貯められためっき液10は、その温度T_2が、前記基板のめっき浴の適温より低温の、例えば30~50℃程度となるように冷却装置17で冷却されてめっき液循環槽12に戻され、熱交換器18で一定の温度(例えば30~50℃)に保たれるように構成されている。

【0022】例えばホルマリン等の還元剤の副反応であるカニッツァーロ反応は、熱活性化過程で促進されており、めっき液10の温度を10℃程度低下させただけで、カニッツァーロ反応の反応速度が半分以下になると考えられる。そのため、めっき液循環槽12内でのめっき液10の温度T_2を基板のめっき浴の適温である60

℃前後から、これより低温の３０～５０℃程度にすることで、めっき液循環槽１２内で生じるカニッツァーロ反応そのものを抑制することができる。しかも、めっき液１０は、めっき処理槽１１内に半導体基板Wを出入れしている間中、めっき液循環槽１２内に全て戻っていて、殆どの時間めっき液循環槽１２内に存在しており、必要な時のみ基板のめっき浴の適温まで加熱されるので、常時めっきの適温の６０℃前後に保持されている場合と比較して、カニッツァーロ反応を大幅に抑制することができる。

【００２３】この実施の形態の無電解銅めっき装置にあっては、めっき液循環槽１２内に、例えば３０～５０℃に保持しためっき液１０を貯めておき、めっき処理槽１１内に半導体基板Wを保持した後、めっき処理槽１１内にめっき液１０を循環させて半導体基板Wにめっき処理を施す。この時、めっきは、その適温の６０℃前後で行われ、めっきを行う時以外は、めっき液１０は、例えば３０～５０℃に保たれて、カニッツァーロ反応が抑制される。

【００２４】図３は、本発明の第２の実施の形態の無電解銅めっき装置を示すもので、このめっき装置は、対向式熱交換器２０を備え、この対向式熱交換器２０の加熱側２１を前記往路１３内に配置して該加熱側２１に前記めっき処理槽１１に入るめっき液１０が流れ、冷却側２２を前記復路１４内に配置して該冷却側２２に前記めっき液循環槽１２に戻るめっき液１０がそれぞれ流れるようにするとともに、対向式熱交換器２０とめっき処理槽１１とを結ぶ往路１３内に加熱装置２３を、対向式熱交換器２０とめっき液循環槽１２とを結び復路１４内に冷却装置２４をそれぞれ設けたものである。

【００２５】この実施の形態の無電解銅めっき装置によれば、めっき液１０の持つ熱量を対向式熱交換器２０を介してめっき液１０の加熱及び冷却に有効に利用し、しかも、対向式熱交換器２０による熱量の不足分を加熱装置２３及び冷却装置２４で補うことで、エネルギ消費を最小限に抑えることができる。

【００２６】

【発明の効果】以上説明したように、本発明によれば、めっき処理槽内のめっき液の温度を基板のめっき浴の適温に、めっき液循環槽内のめっき液の温度を基板のめっき浴の適温より低い温度にすることで、通常、殆どの時間めっき液が保持されているめっき液循環槽内でのカニッツァーロ反応そのものを抑制することができる。これにより、めっき液の寿命を延ばすとともに、このめっき液の組成維持等の管理を容易に行うことができる。

【図面の簡単な説明】

【図１】本発明の無電解銅めっき装置によってめっきを行う工程の一例を示す断面図である。

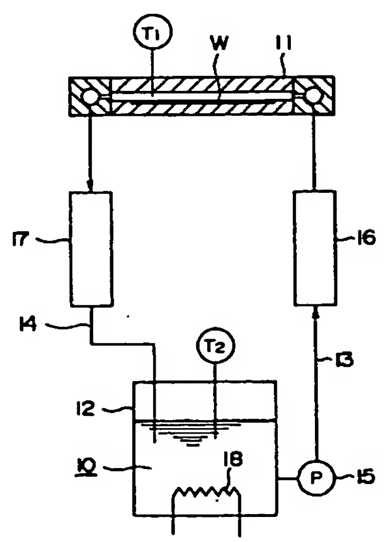
【図２】本発明の第１の実施の形態の無電解銅めっき装置の概要を示す図である。

【図３】本発明の第２の実施の形態の無電解銅めっき装置の概要を示す図である。

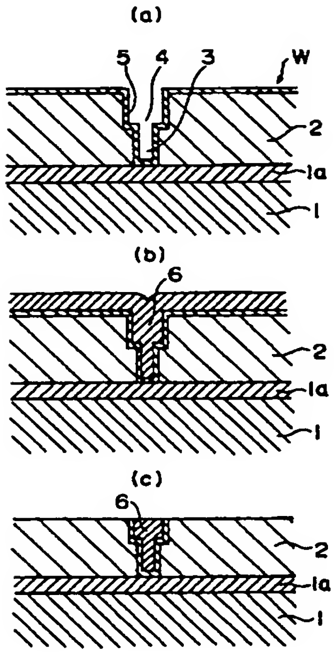
【符号の説明】

１０　めっき液
１１　めっき処理槽
１２　めっき液循環槽
１３　往路
１４　復路
１６，２３　加熱装置
１７，２４　冷却装置
２０　対向式熱交換器
W　半導体基板

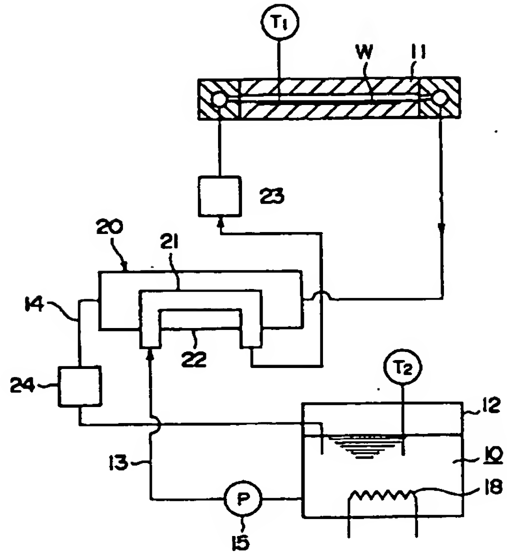
【図２】



【図1】



【図3】



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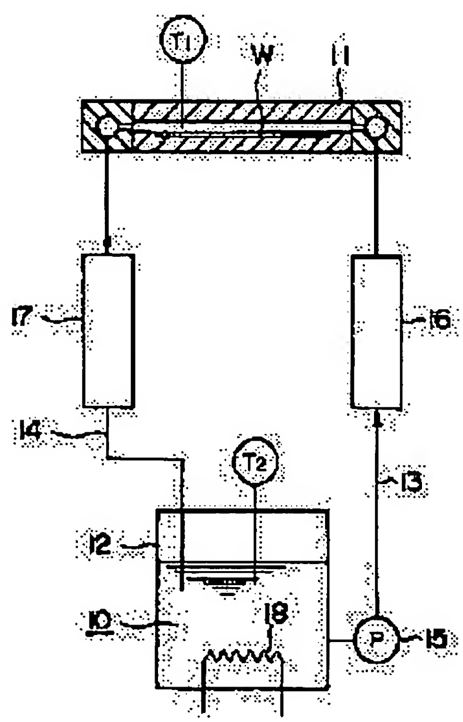
(54) ELECTROLESS COPPER PLATING DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide an electroless copper plating device capable of prolonging the service life of a plating soln. facilitating the management of the plating soln. by suppressing the Cannizzaro reaction as it is as much as possible.
SOLUTION: This device is provided with a plating treating tank 11 holding a substrate W and applying electroless copper plating on the substrate W and a plating soln. circulating tank 12 stored with a plating soln. 10 at the inside and circulating the plating soln. 10 between it and the plating treating tank 11, and the temp. T1 of the plating soln. 10 in the plating treating tank 11 is made higher than the temp. T2 of the plating soln. 10 in the plating soln. circulating tank 12 (T1>T2).



LEGAL STATUS
[Date of request for examination]

Methanol

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the non-electrolytic-copper plating equipment of the use of filling up with copper the slot for wiring which started non-electrolytic-copper plating equipment, especially was formed in the semiconductor substrate.
[0002]
[Description of the Prior Art] In order to form a wiring circuit on a semiconductor substrate conventionally, after using sputtering etc. on the substrate side and forming a conductor, the chemical dry etching using pattern masks, such as a resist, had removed the membranous garbage further.
[0003] Generally as a metallic material for forming a wiring circuit, aluminum (aluminum) or the aluminium alloy was used widely. however -- as the degree of integration of a semiconductor becomes high -- wiring width of face -- thin -- becoming -- current density -- increasing -- thermal stress and a temperature rise -- being generated -- a stress migration and electromigration -- just -- being alike -- fear, such as an open circuit or a short circuit, arises It is in the inclination which becomes still more remarkable as aluminum wiring thin-film-izes this inclination.
[0004] Then, in order to avoid the resistance loss by energization, it is required that conductive material, such as high copper, should be adopted more as wiring formation. However, dry etching is difficult for copper or its alloy, and after forming membranes all over a substrate, adoption of the above-mentioned method of forming a pattern is difficult. Then, the slot for wiring of a predetermined pattern is formed beforehand, and the process filled up with copper or its alloy into it can be considered. According to this, the process which removes a film by etching is unnecessary, and a copper wiring layer can be formed by performing the polish process for removing a surface level difference. Moreover, the portion called plug which connects the vertical layer of a multilayer-interconnection circuit also has the advantage which can be formed simultaneously.
[0005] However, wiring width of face followed on making it detailed, and became a remarkable high aspect ratio (ratio of the depth, a diameter, or width of face), and restoration of a uniform metal was difficult for the configuration of such a wiring slot or a plug in sputtering membrane formation. Moreover, with copper or its alloy, although the chemical vapor-growth (CVD) method was used as a membrane formation means of various material, when it was difficult to prepare a suitable gas raw material and it adopted an organic raw material, there was a trouble that carbon (C) mixed into a deposition film after this, and migration nature went up. Then, the method of making a substrate immersed into plating liquid and performing non-electrolytic-copper plating is proposed. In membrane formation by the starting plating, it becomes possible to fill up the wiring slot of a high aspect ratio with copper uniformly.
[0006] Reducing agents, such as formalin (HCHO) and a glyoxylic acid (CHOCOOH), are contained in the plating liquid used here by non-electrolytic-copper plating. Moreover, for this reason, the optimal temperature of the plating liquid in the case of raising the quality (elongation) of plating deposit speed and a coat by non-electrolytic-copper plating was around 50-80 degrees C, and plating liquid is stored at

fixed temperature (before or after 60 degrees C) in the thermostat (plating liquid circulation tank) generally equipped with heating apparatus, and it was constituted so that between the plating processing tubs which perform plating processing might be circulated.
[0007]
[Problem(s) to be Solved by the Invention] Since the reducing agent is contained in the plating liquid used for non-electrolytic-copper plating, if it is in the Cannizzaro reaction which is the side reaction of this reducing agent, i.e., formalin, and a glyoxylic acid, the following reaction arises.
2 HCHO+OH-->CH3 OH+HCOO-2CHOCOOH+2OH-->C2O42-+HOCH2 COOH+H2O[0008] And since it is impossible to suppress this reaction completely, the by-product generated by this reaction will reduce the purity and the dissolved acid quantum of plating liquid, and will affect a plating growth rate. For this reason, the present condition was that non-electrolytic-copper plating is the plating method
methano
which is hard to manage. In addition, although adding a methanol in plating liquid was performed in order to prevent degradation of the plating liquid resulting from a Cannizzaro reaction, this method does not suppress the Cannizzaro reaction itself and there was a fixed limitation in the effect.
[0009] While succeeding in this invention in view of the above-mentioned situation, suppressing the Cannizzaro reaction itself as much as possible and prolonging the life of plating liquid, it aims at offering the non-electrolytic-copper plating equipment which made management of plating liquid easy.
[0010]
[Means for Solving the Problem] The non-electrolytic-copper plating equipment of this invention carries out [having and having made the plating processing tub which holds a substrate and performs non-electrolytic-copper plating to this substrate, and the plating liquid circulation tank which plating liquid is stored / circulation tank / and makes the interior circulate through plating liquid between the aforementioned plating processing tubs the temperature of the plating liquid in the aforementioned plating processing tub become high than the temperature of the plating liquid in the aforementioned plating liquid circulation tank, and] as the feature.
[0011] According to the above-mentioned this invention, it is thought that the above-mentioned Cannizzaro reaction is promoted by the thermally activated process, and this reaction can be suppressed by reducing the temperature of plating liquid. Then, the Cannizzaro reaction in the plating liquid circulation tank where almost all time plating liquid is usually held in the temperature of the plating liquid in a plating processing tub by making temperature of the plating liquid in a plating liquid circulation tank into low temperature from the optimal temperature of the plating bath of a substrate at the optimal temperature of the plating bath of a substrate itself can be suppressed.
[0012] Moreover, the temperature gradient of the temperature of the plating liquid in the aforementioned plating processing tub and the temperature of the plating liquid in the aforementioned plating liquid circulation tank is characterized by being at least 10 degrees C or more. Thereby, the speed of a Cannizzaro reaction can be lowered to below a half by reducing the temperature of the plating liquid in a plating liquid circulation tank by 10 degrees C or more from the optimal temperature of the plating bath of a substrate.
[0013] Moreover, it is characterized by forming heating apparatus in the outward trip from the aforementioned plating liquid circulation tank to the aforementioned plating processing tub, and preparing the cooling system in the return trip, respectively. This heats plating liquid to the optimal temperature of the plating bath of a substrate with heating apparatus, just before going into a plating processing tub, and before returning to a plating liquid circulation tank, it can cool with a cooling system.
[0014] Furthermore, it has an opposite formula heat-exchange machine, and is characterized by making it the plating liquid with which the plating liquid which goes into a this opposite formula heat exchanger heating-side at the aforementioned plating processing tub returns to the aforementioned plating liquid circulation tank at a cold end flow, respectively. Thereby, consumption of energy can be held down to the minimum, using the heating value which plating liquid has effective in heating and cooling of plating liquid.
[0015] Moreover, it is characterized by for heating apparatus tying an opposite formula heat exchanger

and a plating liquid circulation tank in the path which connects the aforementioned opposite formula heat exchanger and a plating processing tub, and preparing the cooling system in a path, respectively. Thereby, the insufficiency of the heating value by the opposite formula heat exchanger is suppliable with heating apparatus and a cooling system.

[0016]

[Embodiments of the Invention] Hereafter, the non-electrolytic-copper plating equipment of the form of operation of this invention is explained with reference to a drawing. This non-electrolytic-copper plating equipment gives copper plating to the slot of the front face of a semiconductor substrate, is used for forming the wiring layer which consists of a copper layer, and explains this process with reference to drawing 1 .

[0017] That is, as shown in drawing 1 (a), the insulator layer 2 which consists of SiO2 accumulates on conductive-layer 1a on the semiconductor substrate 1 in which the semiconductor device was formed, a contact hole 3 and the slot 4 for wiring are formed in the semiconductor substrate W by lithography etching technology, and the barrier layer 5 which consists of TiN etc. on it is formed in it.

[0018] And while making copper fill up with giving copper plating to the front face of the aforementioned semiconductor substrate W in the contact hole 3 of the semiconductor substrate 1, and a slot 4 as shown in drawing 1 (b), a copper layer 6 is made to deposit on an insulator layer 2. Then, by chemical mechanical polish (CMP), the copper layer 6 on an insulator layer 2 is removed, and the front face of a copper layer 6 and the front face of an insulator layer 2 with which the contact hole 3 and the slot 4 for wiring were made to fill up are mostly ground at the same flat surface. The wiring which consists of a copper layer 6 by this as shown in drawing 1 (c) is formed.

[0019] As drawing 2 shows the outline of the non-electrolytic-copper plating equipment of the form of operation of the 1st of this invention and shows it in this drawing, to this plating equipment The semiconductor substrate W is held and it has the plating processing tub 11 which introduces plating liquid 10 into the interior and performs non-electrolytic-copper plating to this semiconductor substrate W, and the plating liquid circulation tank 12 which collects plating liquid 10 and is made to circulate through plating liquid 10 between the aforementioned plating processing tubs 11. 0.1 mols [/l.] formalin is contained in the aforementioned plating liquid 10 as a reducing agent.

[0020] The aforementioned plating liquid circulation tank 12 and the plating processing tub 11 are connected with the outward trip 13 and return trip 14 which constitute a circulation path, the pump 15 for circulation and heating apparatus 16 are formed in this outward trip 13, and the cooling system 17 is formed in the return trip 14, respectively. Furthermore, inside the aforementioned plating liquid circulation tank 12, the heat exchanger 18 for making regularity temperature of the plating liquid 10 stored here is arranged.

[0021] Thereby, with the drive of the pump 15 for circulation, plating liquid 10 is sent one by one in the plating processing tub 11, and is returned in the plating liquid circulation tank 12 after the plating bath end of a substrate. At this time, it is heated with heating apparatus 16 so that the temperature T1 of the plating liquid 10 in the plating processing tub 11 may become for example, 60-degree-C order which is the optimal temperature of the plating bath of a substrate. On the other hand, it is cooled with a cooling system 17 and the plating liquid 10 which was able to be collected in the plating liquid circulation tank 12 is returned to the plating liquid circulation tank 12 so that the temperature T2 may become about 30-50 degrees C of low temperature from the optimal temperature of the plating bath of the aforementioned substrate, and it is constituted so that it may be maintained at fixed temperature (for example, 30-50 degrees C) by the heat exchanger 18.

[0022] For example, the Cannizzaro reaction which is the side reaction of reducing agents, such as formalin, is promoted by the thermally activated process, only reduced the temperature of plating liquid 10 by about 10 degrees C, and is considered that the reaction rate of a Cannizzaro reaction becomes below a half. Therefore, the Cannizzaro reaction itself which produces the temperature T2 of the plating liquid 10 in the plating liquid circulation tank 12 from 60-degree-C order which is the optimal temperature of the plating bath of a substrate in the plating liquid circulation tank 12 by making it from this about 30-50 degrees C of low temperature can be suppressed. And since plating liquid 10 has

returned altogether in the plating liquid circulation tank 12, exists in almost all the time plating liquid circulation tank 12, and it is heated to the optimal temperature of the plating bath of a substrate only when required while taking the semiconductor substrate W in the plating processing tub 11, it can suppress a Cannizzaro reaction sharply as compared with the case where it is always held before and after 60 degrees C of the optimal temperature of plating.
[0023] In the plating liquid circulation tank 12, if it is in the non-electrolytic-copper plating equipment of the gestalt of this operation, after collecting the plating liquid 10 held at 30-50 degrees C and holding the semiconductor substrate W in the plating processing tub 11, plating liquid 10 is circulated for example, in the plating processing tub 11, and plating processing is performed to the semiconductor substrate W. At this time, except when galvanizing by performing plating before and after 60 degrees C of the optimal temperature, plating liquid 10 is kept at 30-50 degrees C, and a Cannizzaro reaction is suppressed.
[0024] Drawing 3 is what shows the non-electrolytic-copper plating equipment of the gestalt of operation of the 2nd of this invention. this plating equipment The plating liquid 10 which is equipped with the opposite formula heat exchanger 20, arranges heating side 21 of this opposite formula heat exchanger 20 in the aforementioned outward trip 13, and goes into this heating side 21 at the aforementioned plating processing tub 11 flows. While making it the plating liquid 10 which arranges a cold end 22 in the aforementioned return trip 14, and returns to the aforementioned plating liquid circulation tank 12 at this cold end 22 flow, respectively The opposite formula heat exchanger 20 and the plating liquid circulation tank 12 are tied for heating apparatus 23 in the outward trip 13 which connects the opposite formula heat exchanger 20 and the plating processing tub 11, and a cooling system 24 is formed in a return trip 14, respectively.
[0025] According to the non-electrolytic-copper plating equipment of the form of this operation, the heating value which plating liquid 10 has can be used effective in heating and cooling of plating liquid 10 through the opposite formula heat exchanger 20, and, moreover, energy expenditure can be held down to the minimum by compensating the insufficiency of the heating value by the opposite formula heat exchanger 20 with heating apparatus 23 and a cooling system 24.
[0026]
[Effect of the Invention]

CLAIMS

[Claim(s)]
[Claim 1] The non-electrolytic-copper plating equipment carry out [having and having made the plating processing tub which holds a substrate and performs non-electrolytic-copper plating to this substrate, and the plating liquid circulation tank which plating liquid is stored / circulation tank / and makes the interior circulate through plating liquid between the aforementioned plating processing tubs the temperature of the plating liquid in the aforementioned plating processing tub become higher than the temperature of the plating liquid in the aforementioned plating liquid circulation tank, and] as the feature.
[Claim 2] Non-electrolytic-copper plating equipment according to claim 1 with which the temperature gradient of the temperature of the plating liquid in the aforementioned plating processing tub and the temperature of the plating liquid in the aforementioned plating liquid circulation tank is characterized by being at least 10 degrees C or more.
[Claim 3] Non-electrolytic-copper plating equipment according to claim 1 or 2 characterized by forming heating apparatus in the outward trip from the aforementioned plating liquid circulation tank to the aforementioned plating processing tub, and preparing the cooling system in the return trip, respectively.
[Claim 4] Non-electrolytic-copper plating equipment according to claim 1 or 2 characterized by making it the plating liquid with which the plating liquid which is equipped with an opposite formula heat exchanger and goes into a this opposite formula heat exchanger heating-side at the aforementioned plating processing tub returns to the aforementioned plating liquid circulation tank at a cold end flow, respectively.
[Claim 5] Non-electrolytic-copper plating equipment according to claim 4 characterized by preparing the cooling system, respectively in the path with which heating apparatus ties the aforementioned opposite formula heat exchanger and a plating liquid circulation tank in the path which connects the aforementioned opposite formula heat exchanger and a plating processing tub.

[Translation done.]